A characteristic of most of these basins is the occurrence of underground barriers (dikes) or of lateral constrictions, or both, which interrupt the percolation of the ground-water streams. Taking, for example, the San Fernando Valley, at Van Nuys the valley has a width of 8 miles and a depth to bedrock of 1,000 feet or more. At its outlet the valley is constricted from Burbank to Elysian Park by the approach from either side of the hill formation, narrowing the valley down to a width of three-fourths mile. This is the Elysian Park "narrows." There is, furthermore, an underground sandstone barrier which crosses the narrows at a depth of less than 200 feet below the surface. The combined effect of lateral constriction and barrier is to force the ground water to the surface and to form the rising stream of the Los Angeles River. This river begins as a small stream in the vicinity of Van Nuys and gradually increases on its course toward the Narrows to a flow of 40 to 50 second-feet, even in the summer months of a dry period. The Los Angeles River is therefore strictly a ground-water stream (except for its flood flow). In order to prevent pollution, the river is now drained by infiltration pipe lines, from whence it is conveyed to the city.

San Gabriel Valley extends from Pasadena to San Dimas, a distance of some 20 miles, and has a depth of alluvial fill of over 1,000 feet. At the Whittier Narrows the valley is constricted to a width of about 2 miles. The depth of fill at this point is about 480 feet. The effect of the "narrows" is a stream of rising water, beginning about at the Foothill Boulevard with a small stream and increasing, as the Mission Street Bridge is approached, to a river carrying 60 to 120 second-feet. This supply is diverted in a number of irrigation ditches.

The many narrows constricting our valleys or basins are indicated on Plate 4.

In the ground-water basins water will remain pure and potable for indefinite periods and is available for abstraction over long periods as it percolates from the mountains to the sea.

These ground-water basins present a natural and practical solution for the regulation of the otherwise erratic water supply of southern California, making it possible to store water from a wet period into a dry period; in other words, permitting of a cyclic regulation of water supply. For this reason they are the fundamental physical factor which made possible the development of this country.

Too much emphasis can not be placed on the economic importance of the deep gravel beds which underlie our valleys. The layman is inclined to lay stress on surface storage, believing that the water problem can be solved by the construction of surface reservoirs. The proper function of our flood control and conservation reservoirs is that of detaining floods. From such temporary storage the flood waters may conveniently be carried on to the gravel deposits below the mouths of canyons and there caused to sink into the ground, to become a portion of the ground water underlying our valleys. This method of conservation is also known as the spreading of flood waters and is now practiced on practically all rivers and streams of southern California.

AGRICULTURAL METEOROLOGY AND RAISING THE AGRICULTURAL PRODUCTIVITY

551.5 : 633

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1. The main work of contemporary agricultural meteorology consists at the present almost exclusively in parallel observations on the growth of some crops and the influence on them of meteorological factors.

2. The object of these observations, started in Russia in 1906 and in America in 1915–16, is the fixation of the "critical periods" in the growth of plants, in which they are most sensitive to excess and deficiency of heat and humidity, and the "correlational interdependence" between the harvest and the combination of the heat and humidity in the several intervals of the vegetative period.

3. This interdependence is of a rather vague character. It varies with the different climatic conditions foı one and the same crop and shows a tendency of adapting itself passively to the climate.

The method applied in these researches is a passive observing one.

4. The meteorological observations, based on the contemporary international agreements, have but a limited value in the comparison of climates on broad scales, and their importance for practical agronomy is very small.

5. As a counterpoise to the foregoing and in addition to it, an experimental method is proposed to be applied at special microclimatic stations, observatories, and biometeorological laboratories.

6. The data on microclimate, or rather on bioclimate, are to be gathered by means of observations made with special instruments more exact and more sensitive than the ordinary ones, in the lowest strata of the atmosphere, 0 to 15 meters, having as their object the fixation of the movement and the limits of fluctuations of those meteorological factors most important for the life of the plants, which can directly bring to light the characteristics of the local climate.

7. The actinometric sections of the observatories, possessing exact physical instruments, mainly photo-actinometric, are to start a detailed study of solar energy, direct and dispersed, in the spectrum as a whole and also in its different regions, taking into account the local conditions of the solar climate.

8. Hand in hand with this the laboratories (biometeorological sections of the observatories) are to conduct, systematically and in detail, isolated vegetation experiments, using natural and artificial sources of light and an assortment of photophilters, the influence of light, direct and dispersed in the spectrum as a whole, and also in its different regions, on the development and chemism of plants.

9. As data on microclimate are gathered, the different elements should be in the limits fixed by experience for given regions, and introduced into the vegetation experiments as new variables, enabling thereby the calculation of the influence of divers factors of the bioclimate on the growth of different crops.

10. The totality of gathered facts will enable us to fix, with the aid of specialists—chemists, physiologists-botanists, selectioneers, etc.—the climatic "formulary" of the plant, depending on the natural conditions of the region, and thus to tie together the vegetable world with climatic conditions by a causal and uniform nexus.

11. The struggle against the natural forces of a meteorological character is mainly the business of technical and rationalized agriculture; and if it be sufficiently

industrialized, the influence of these forces can be reduced to a minimum. At the same time we can raise the favorable conditions, leaning on a firm scientific basis. The main lines of the struggle are already marked out, and with intense research studies success is assured.

12. If realized, this should give a mighty impulse to the raising to a higher level the quantity of agricultural production, on a basis of broad industrialization and enlarged scale, with reconstruction on a strictly scientific basis.

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WEATHER ABNORMALITIES IN UNITED STATES

HEAVY RAINS IN TEXAS AND OKLAHOMA, MAY, 1929

ALFRED J. HENRY

(FIFTH NOTE)

Ordinarily one thinks of the rainfall as being due primarily to the frequency and horizontal movement of cyclonic storms or simply shallow barometric depressions, and this idea has some basis of fact when applied to certain parts of the country. The preliminary study in the preparation of this paper showed, however, that a different conception is equally valid, as will appear in subsequent paragraphs.

In May, 1929, precipitation in Texas was 4.04 and in Oklahoma 3.30 inches above the State normals, respectively. In order to reach a conclusion as to the ideal conditions for heavy rains in the region considered, I have made a detailed examination of the total rainfall for the month of May from the beginning of state-wide distribution of rainfall stations in 1891 to date. I have selected for detailed examination those months which gave the greatest May precipitation of record. These are:

For Oklahoma, May, 1902: State average, 10.13 inches; departure, 5.72 inches.

For Texas, same month: State average, 3.93 inches; departure, 0.27 inches.

Greatest amount for Texas, May, 1929, 7.70 inches; departure, 4.04 inches.

Second greatest for Texas, May, 1914, 7.68 inches; departure, 4.02 inches.

For Oklahoma in May, 1929, 7.67 inches; departure, 3.30 inches.

For Oklahoma in May, 1914, 5.17 inches; departure, 0.80 inches.

Thus it is seen that the two States do not closely parallel each other in the distribution of heavy rains.

The details of the rains of May, 1929, are shown in Table 1 below:

TABLE 1.—*Monthly mean and extreme values of precipitation in Texas and Oklahoma, May, 1929*

Divisions	Number of stations	Precipitation (inches)			Monthly departure
		Average	Greatest		
			Monthly	24 hours	
Texas:					
Northwestern	51	4.37	8.85	6.30	+1.47
Northeastern	26	8.43	15.29	7.00	+3.80
Western	36	3.62	8.86	3.62	+1.13
Central	37	10.88	20.46	7.22	+6.19
Eastern	13	13.48	22.49	11.05	+8.63
Southwestern	47	8.62	17.18	6.16	+5.05
Coast	37	9.42	17.86	7.65	+5.17
Oklahoma:					
Eastern	27	9.15	16.25	4.70	+4.33
Central	26	8.98	12.90	6.50	+3.94
Western	31	5.20	14.78	7.86	+1.96

The detailed examination of the daily weather maps which gave the greatest monthly totals of precipitation for the region under consideration clearly show that the controlling pressure formations are (1) strong anticyclones with central pressure between 30.50 and 30.60 inches overspreading one of the northern tier of States from North Dakota to Michigan; (2) at the same time pressure should be low over the Great Basin, a depression with central pressure of 29.70 to 29.80 inches over Nevada or Utah.

The anticyclone tends to spread fan shaped to the southeast with a slow movement; the Utah depression has a somewhat uncertain movement and development. In most cases the southern end will in a day or so occupy New Mexico and part of west Texas as a shallow depression, or the northern end of the original trough may develop and move to the northeast as a going cyclone; in that case a secondary will usually develop over west Texas.

The circulation proper to the anticyclone as it spreads to the southeast is manifest by east to southeast winds on its southwest periphery, and these winds are mainly from the Gulf of Mexico. They are augmented in force by the presence of low pressure to the west over New Mexico and adjoining areas. When the anticyclone is of great magnitude it may persist for as long as a week before passing over the Atlantic. Meanwhile the southeast winds and rain, locally heavy because of long duration prevail, there being as many as three or four different periods of relatively long-continued rains in the States named. These may be classed as warm front rains.

Rains due to a cold front may vary the situation, but their occurrence is not so frequent as the first named. Cold front rains occur when a strong anticyclone advances southward from Montana into a trough of low pressure left over Texas as a residual from a northern cyclone that has passed to the eastward. A 4-day rain, due wholly to the northern anticyclone, is not uncommon.

Moderately heavy rains, especially in Oklahoma, occur when the number of secondary cyclones that originate in the spring months over the southern Plateau region and move east-northeast over northwest Texas and Oklahoma is fairly large, say, three or four in any one month. Dry weather is the rule when southern plateau cyclones do not develop and the cyclonic movement eastward is confined to the northern border States.

May is the month of greatest precipitation in Oklahoma, the State average being 4.37 inches, with a rather large number of stations having an average of 5 inches and slightly over. Although the State is not far from the center of the continent, its average May rainfall is not exceeded in any other part of the country. The greater rainfall of this month is doubtless due to the large opportunity that is present for vertical convection and also the overrunning and underrunning of air masses of different temperature and moisture content. These conditions are best developed in the months April–June.

The foregoing is, of course, rather broadly generalized; the details of pressure distribution will follow the plan outlined more or less closely, but there will be differences. As an example of the closeness of fit I give the detailed pressure distributions that were responsible for the heavy rains of May, 1929, in Texas and Oklahoma; these were grouped around four separate periods totaling 18 days as given below:

Rains of May 1–4, 1929.—These were cold front rains due to the southeastward advance of an anticyclone